Weatherwise

Long Range Weather Forecasting

Glamour Comes to the Meteorologist

Record Snowcover

American Meteorological Society

March or Otherwise

Weather by Starlight

The Early March Cold

Vol. 1, No. 2, April, 1948

"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE" — BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

COPYRIGHT, 1948, BY AMATEUR WEATHERMEN OF AMERICA

DAVID M. LUDLUM, *Director*
Amateur Weathermen of America

HANS NEUBERGER, *Technical Editor*

CHARLES A. FEDERER, JR., *Editor*

ROBERT E. COX, *Assistant Editor*

ERIC SLOANE, *Art Director*

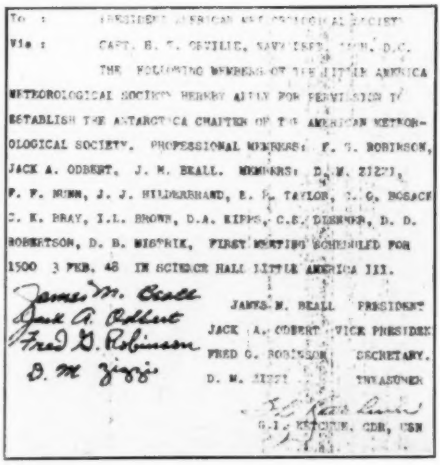
Antarctic Meteorology

SCIENCE HALL, Little America III, was the location of the first meeting of the Antarctic Branch of the American Meteorological Society, all of whose 14 members are presently with U. S. Navy Task Force 39. The meeting was held on February 3, 1948, and guest speaker was Dr. E. T. Appel, professor of geology from Syracuse University, who is an observer for the Department of the Interior. He discussed the relative movement of the different ice layers in the ice shaft adjacent to Science Hall. He also described the methods used to photograph ice crystals, and to determine density and water content of ice samples.

Officers of the new AMS branch are James M. Buell, USWB, president; Lt. Jack A. Odbert, USN, vice-president; Lt.-Comdr. Fred G. Robinson, USN, secretary; and Chief Aerographers Mate D. M. Rizzi, USN, treasurer.

The original copy of the minutes was transmitted by Navy radiophoto directly from Little America, and a duplicate is permanently located in Science Hall. The application for membership of the most southern branch of the society, reproduced here, the minutes, and a picture of the first meeting (see front cover) were received by radiophoto within 24 hours of the time of the meeting. The transmission was by the same methods that weather maps are presently being communicated by radiophoto facsimile the world around.

During the past year, the farthest north branch of the AMS was also formed, at Fairbanks, Alaska.



To : PRESIDENT AMERICAN METEOROLOGICAL SOCIETY

Via : CAPT. H. T. ORVILLE, NAVY DEPT., WASH., D.C.

THE FOLLOWING MEMBERS OF THE LITTLE AMERICA METEOROLOGICAL SOCIETY HEREBY APPLY FOR PERMISSION TO ESTABLISH THE ANTARCTICA CHAPTER OF THE AMERICAN METEOROLOGICAL SOCIETY. PROFESSIONAL MEMBERS: F. T. ROBINSON, JACK A. ODBERT, J. M. BEALL. MEMBERS: D. M. ZIZZI, P. F. MUNN, J. J. HILDEBRAND, E. F. TAYLOR, T. O. BOSACK C. E. BRAY, I.L. BROWN, D.A. RIPPS, C.S. DISHNER, D. D. ROBERTSON, D. B. MIGNERIK, FIRST MEETING SCHEDULED FOR 1500 3 FEB. 48 IN SCIENCE HALL LITTLE AMERICA III.

James M. Beall
Jack A. Odbert
Fred D. Robinson
D. M. Zizzi

JAMES M. BEALL PRESIDENT
JACK A. ODBERT VICE PRESIDENT
FRED G. ROBINSON SECRETARY
D. M. RIZZI TREASURER

G.I. KITCHIN, CDR, USN

Vol. 1, No. 2 April, 1948

CONTENTS

Remarks on Long Range Weather Forecasting—Jerome Namias 23
Glamour Comes to the Meteorologist—G. B. Weir 27
Record Snowcover 28
American Meteorological Society 29
March or Otherwise—D. C. Cameron 30
Weather by Starlight—Eric Sloane 32
Amateur Weathermen of America 34
Forecasting the Weather 36
The Early March Cold 38
551.5 41
Workshop for Weathermen–Charles A. Laird 42
Cover: Radiophoto picture of first meeting of the Little America Meteorological Society. Transmission distance was about 11,000 miles. Via U. S. Navy Radiophoto.

WEATHERWISE is published bimonthly by Amateur Weathermen of America, Franklin Institute, Philadelphia 3, Pa. Membership in the AWA costs $3.00 per year, of which $2.00 is for a subscription to WEATHERWISE and $1.00 for general dues, for members in the United States and possessions and in the armed services. Add 50 cents per annum for postage to Canada and all countries of the Pan-American Postal Union; add $1.00 for all other foreign countries. Make checks and money orders payable to Amateur Weathermen of America. Send notice of change of address three weeks in advance, giving old address.

General, circulation, and advertising offices: Franklin Institute, Philadelphia 3, Pa. Articles and pictures are welcome, but unsolicited manuscripts must have return postage provided by the author.

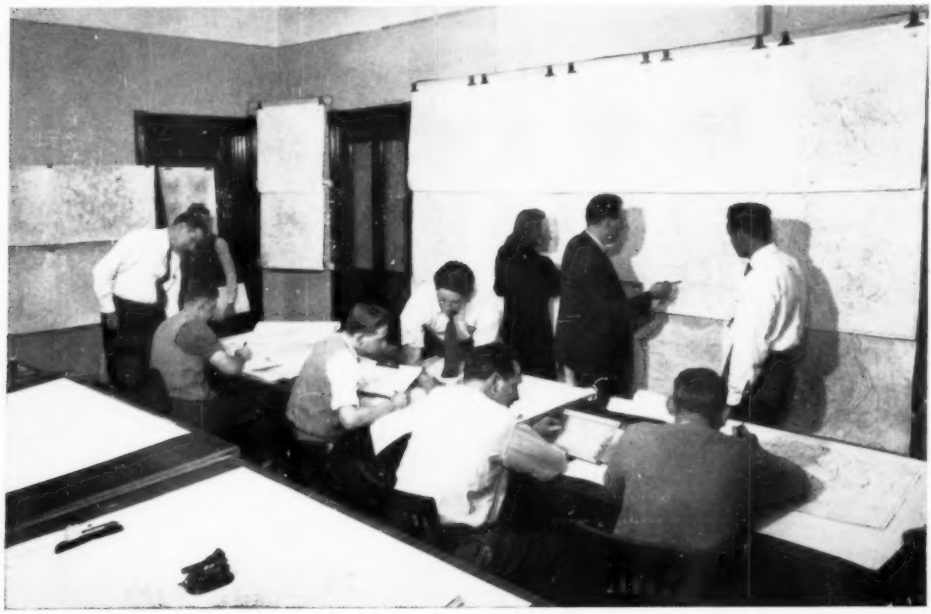
Remarks on Long Range Weather Forecasting

JEROME NAMIAS, CHIEF, EXTENDED FORECAST SECTION, U. S. WEATHER BUREAU

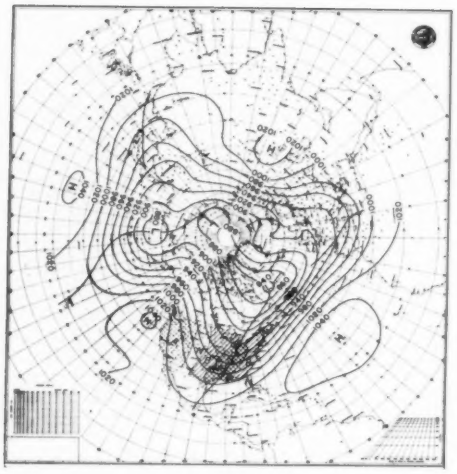
ORDINARY methods used in the preparation of short range weather forecasts show little if any skill beyond a period of about 48 hours. This time interval is generally arbitrarily set as the dividing line between the domains of short and long range forecasting. With this definition the field of long range forecasting may span any period from 48 hours to eternity.

While it is a relatively simple matter to "make a forecast" for any period, however far in advance (requiring only simple language, not even the Latin of a doctor's prescription), it is quite another matter to make such a forecast using intelligible scientific procedures. It is still more difficult to make forecasts which show a *significant* degree of *skill*. Here the words in italics have special meanings which permit little flexibility. Forecasts demonstrating skill must show a higher verification than any simple use of climatic statistics. For significance they must tell with some degree beyond chance the *departures from normal*, or anomalies, of the weather elements for the forecast period. When this criterion of success is set for long range weather forecasts most so-called long range predictions fade into the ignominious realm of chance. This does not imply that climatic statistics cannot be useful as a guide to future weather. In fact, the intelligent long range forecaster uses climatology as background material for his forecast. He has at the outset a good statistical analysis of past weather records — normals, frequencies, and other pertinent statistics. But his *forecast* begins here.

Despite the fact that one hears from time to time of amazingly successful forecasts for periods up to and even beyond a year in ad-



A stage in the preparation of a five-day forecast. Here certain analyses and computations are being completed for use by forecasters. On the left wall are daily weather maps at sea level and 700 mb (about 10,000 feet) covering most of the Northern Hemisphere. On the front wall are mean charts and zonal indices for the preceding weeks.



Mean flow pattern at the 700-mb. (about 10,000-foot) surface for the period January 21 to 25, 1948, for the Northern Hemisphere.

vance, science knows of no reliable methods of weather prediction beyond a week in advance, and forecasts for the coming week are still far from the level of accuracy the public desires. Some small degree of success in making monthly forecasts has been achieved in an experiment conducted over the past six years at the U. S. Weather Bureau in Washington, but here again the degree of reliability is too low to warrant public distribution.

Methods of predicting weather for the coming week as practiced by different groups vary as to emphasis on primary tools. These tools generally embrace on the one hand statistical techniques, and on the other, physical reasoning of a qualitative or quantitative nature. Some long range forecasters have also been accused of using intuition. All scientifically creditable methods agree, however, on the following cardinal points:

1. Successful long range forecasting methods must take into consideration the weather and atmospheric circulations not only in the environment but also over areas thousands of miles distant from the point for which the forecast is being made. Evidence accumulated over the past several years suggests that for forecasts of a week the weather over most of the hemisphere must be taken into account.

2. The historical development and evolution of the general circulation for at least two weeks prior to the date of the forecast must be studied carefully.

The wealth of information which therefore must be considered in the preparation of an extended forecast becomes unwieldy in the form of the usual weather maps at sea level or in the upper atmosphere. Methods of summarizing and integrating these data are necessary if they are to be assimilated by the human mind. Here again methods proceed differently. One technique, employed by Russian meteorologists, plots characteristic features on each day's weather map on a common base. Such a *composite chart* has on it the positions of centers of highs and lows, troughs, ridges, and so forth, for the duration of a *natural period* — a period during which cyclone tracks, anticyclone tracks, and regions of development of these systems remain fairly constant in geographical position. Another method divides the Northern Hemisphere into large areas and classifies the general type of circulation going on in accordance with the principal cyclone and anticyclone paths. Here an arbitrary lettering system has been established for the types, and Greek letters are used to differentiate between similar types in different areas. Still another school of thought makes use of *analogues* — maps which are as similar as possible and therefore supposed to lead to similar future weather. The method of analogue selection was developed to its acme during the war when the Air Forces catalogued 40 years of Northern Hemisphere weather maps on punched cards, and only a few human hands pushing buttons could select the day's analogue.

Still another method, practiced at the U. S. Weather Bureau for the past seven years, gets at the summarization and integration problem by the use of mean maps — average distributions of the elements, particularly pressure and temperature, at sea level and aloft, for periods of five days in length.

It would be impossible in this space to describe and compare these methods on a fair basis. Each has its good points as well as its shortcomings. Each has in store many years of research before anything approaching perfection is in sight. Only the system which has been operating as a service function in the Weather Bureau at Washington

for the past seven years (and before that as a research project for five years) will be described here. This *mean circulation method* has as its basis a physical foundation complemented by empirical and statistical studies.

If pressures are interpolated from isobars on many years of daily sea-level maps and averaged point by point for all areas of the Northern Hemisphere for a given month, say January, the resulting chart with isobars constructed becomes the normal sea-level pressure distribution for January. Certain large low and high pressure areas, well known as centers of action, are revealed. These are the Icelandic and Aleutian lows, the Atlantic and Pacific highs of the subtropics, and the North American and Siberian anticyclones — all named after the regions of most frequent occurrence. From these normal charts it is possible to compute with fairly reliable accuracy the prevailing average airflow around the hemisphere in a west-east or east-west direction. Thus in temperate latitudes in January this flow is prevailingly from west to east with an average velocity of about five miles per hour; in polar latitudes there is very little net flow; and in subtropical latitudes there is a net east-to-west drift of about five miles per hour. If a similar procedure of averaging is applied to charts at levels from 10,000 to 30,000 feet in the atmosphere, the east-to-west components largely vanish and there exists a vast whirl of westerly winds surrounding the pole.

It is in this "circumpolar westerly whirl" that the west-to-east moving cyclones and anticyclones of the daily weather map are embedded. If maps are averaged for periods of only one week or one month of one year, it is found that the strength of the west winds and the position of the zone of maximum strength vary considerably from one average or mean map to another. The zone marking the northern boundary of the temperate westerlies in a particular month may, for example, shift far to the south of normal. Such a case in February and March of 1947 resulted in severe continental cold to Europe and Britain with prevailing east winds but abnormal warmth to Labrador (where the east winds bring maritime Atlantic air). Variations in the strength of the west winds over the United States in winter may mean the difference between a warm spell, when Pacific air masses are carried rapidly eastward with strong westerlies, and severe cold as the Pacific source of air is cut off and polar continental air is fed southward from Canada. Numerical measures of strength of the west-east circulation in different latitudes represent important *zonal indices* of the atmospheric circulation.

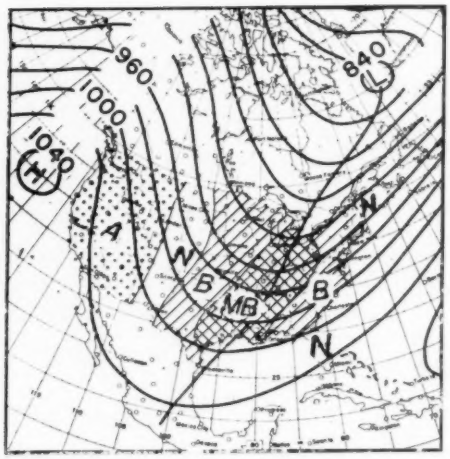
While the west-east components of the circulation are important, it is clear that the north-south flow must also be considered. The circumpolar westerly whirl of the layer from 10,000 to 30,000 feet is by no means straight westerly. It deviates for long stretches of hundreds, sometimes thousands of miles into a southwest or northwest stream. Looked at from a perspective of the entire hemisphere, the westerlies aloft are seen as a meandering river, moving to high latitudes in some areas and then returning to low latitudes at others. A picture of such a characteristic pattern of flow at the 700-millibar level (about 10,000 feet) is given in the accompanying diagram. Lines connecting northernmost points of the curving contours of the westerlies are called ridges, and the lines drawn through southernmost points are troughs. Together the troughs and ridges constitute "waves in the westerlies," whose wave length is measured in terms of the distance from trough to trough or from ridge to ridge. Cold polar air masses are fed into the troughs by the northwesterly flow behind them, while warm air from the subtropics

---

PUBLIC OPINION

Recent press reports carry results of a Gallup poll on the question, "Do you think the official local weather bureau man is doing a good or poor job of forecasting weather conditions for this area?" The answers are reported to have been, in per cent of the total:

Region	*Good*	*Fair*	*Poor*	*No Opinion*
National	51	28	15	6
New England and Middle Atlantic	46	28	22	4
East Central	57	27	10	6
West Central	53	30	13	4
South	54	28	12	6
Far West	51	28	11	10



An enlargement of a portion of the mean flow pattern on page 24 showing observed temperature anomalies over the United States. A stands for above normal: N, near normal: B, below normal: MB, much below normal.

flows northward ahead of the troughs and into the ridges. Each trough system is generally associated with a family of cyclones, the most active of which usually occur just ahead of the principal trough. This cyclone family along the polar front is associated with the convergence of polar and tropical currents from behind and ahead of the troughs.

When followed on five-day mean maps these vast troughs (and ridges) move very slowly, in fact, their average speed in temperate latitudes is only about 15 degrees of longitude eastward per week. On the other hand, the average west-east speed of air particles is about five times as great, so that air continually overtakes and flows through the troughs and ridges.

While the troughs generally move slowly eastward, their speed from week to week is not constant, and they may at times even move from *east to west* (retrograde). The two principal factors governing the motion of mean troughs and ridges are: 1. The wave length between a trough and nearest trough to its west in the same latitude zone. 2. The strength of the west wind component of the atmospheric circulation. With strong west winds and short wave lengths troughs move rapidly eastward; with weak westerlies and long wave lengths the waves either move more slowly, remain stationary, or may even retrograde.

Thus the forecasting of the mean circulation hinges largely on predicting the strength of the west-to-east flow and the positions of the mean troughs and ridges. A number of procedures are used as auxiliary techniques in solving this problem. Some are physical in nature and others statistical. Among the physical methods are formulas for determining wave motions for various seasons, latitudes, and geographic locations; portrayal of areas where warm and cold air are being carried into the ridges and troughs (warm air strengthens ridges but weakens troughs, while cold air has the opposite effect); and the determination of zones of confluence where warm subtropical masses are brought beside cold polar air masses in the zone of the westerlies, thereby effecting sharp increases in speed. Among the principal statistical tools are indications expressed by trends. By certain statistically derived formulas it is possible to compute pressure tendencies for mean maps and to apply kinematic computations as is done with three-hour tendencies on daily maps. On five-day mean maps the tendency interval chosen is two days.

After the forecast of the circulation pattern aloft is completed, a corresponding prognosis is made for the sea-level mean chart. There must be internal consistency between upper air and sea-level prognoses, but the upper air prognosis is considered primary.

After the circulation prognoses are completed the associated average weather characteristics for the period may be forecast. Particular emphasis is usually placed on the temperature and precipitation anomalies over the United States. Certain reasonably objective techniques make possible the forecasting of anomalies from the circulation prognoses, particularly the upper-level prognosis. In general, below normal temperatures are forecast behind troughs (the deeper the trough and the longer the fetch of polar air into it the greater the anomaly of temperature), while above normal temperatures are forecast well ahead of troughs and into ridges. Precipitation is apt to be light be-

(Continued on page 39)

Glamour Comes to the Meteorologist

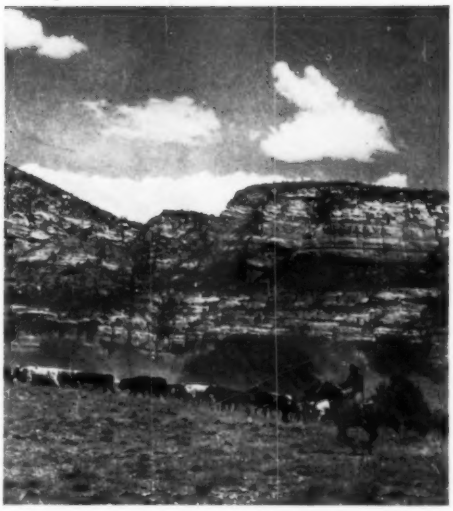
G. B. WEIR

KRICK WEATHER SERVICE, INC.

GLAMOUR AND METEOROLOGY? No connection, you say, and the meteorologist, bent over his maps and charts, would be the first to agree with you. But in Hollywood, where glamour is a highly industrialized commodity, things are different. The film industry's outdoor photographic activities are directly dependent upon atmospheric conditions, and when a single day's exterior shooting may cost as much as twenty thousand dollars, it is imperative that such operations be planned ahead, in order to take advantage of most favorable weather conditions. And so it is that the motion picture industry seeks the meteorologist's advice.

It is true, of course, that southern California on the whole enjoys a generally sunny climate, with the meager rainfall occurring for short periods during the winter months. However, the topography of the area is such that even a clear sunny day will show variations ranging from the damp haze of the coast, through the industrial smoke of the metropolitan area, to the wind and dust of the desert, all within a radius of 25 miles. To the film industry, with its sensitive films and complicated cameras, minor variations in weather may mean the difference between a full day's work and no work at all. In order properly to interpret the variations and changes in the local weather in photographic terms readily grasped by the movie producer, a new type of meteorologist, the photographic consultant, has gradually appeared.

No textbook in existence tells just how hard the wind must blow before it will register on the sound track, or how much the coastal haze hampers Technicolor operations. Thus the consultant's first job is to familiarize himself with studio requirements and the effect of weather on motion picture photography. A new attitude toward the weather map becomes necessary, whereby an approaching warm front means not lowering ceilings but decreasing light values; where a cold front passage means not merely clearing weather but photogenically desirable clouds. And even a new vocabulary has been developed. Meteorological definitions have been set up in terms of photographic requirements.



A still photo exemplifying a day of good light with small amounts of white and fluffy clouds. Republic Studios photograph.

After making a survey of motion picture studios, it was decided to issue forecasts in terms of fractions of a day's workable light. In this way studios could see at a glance whether or not it would be worth planning an exterior location. The length of the average working day for various seasons was established — because of the yellowness of early morning and late afternoon sunlight the working day for color film is about two hours shorter than that for black-and-white.

Definitions, tailored to studio needs, also cover variations in the quality of light. *Good light* is adequate for all black-and-white photography and for close and medium color shots, but inadequate for long color shots, while *fair light* is generally unsatisfactory for color work of any kind. Similar boundaries have been determined for wind and precipitation, and cloud types are given very descriptive nomenclature. Thus cumulus become "white and fluffy clouds," and cirrus are "thin wispy clouds."

The photographic consultant's forecast usually takes the form of a week's trend as to

anticipated general photographic conditions for the southern California area, followed by 24- and 48-hour specific forecasts for each studio location: fraction of a day workable (fair light or better), quality of light, best time of day for photographic purposes, restrictions as to light, and wind. Each forecast bears a confidence rating to aid in evaluation, and a studio planning an expensive day's shooting will frequently adjust its schedule to take advantage of a high-confidence forecast.

The photographic consultant's job is more than just that of a forecaster. Important though the written forecast is, it is completely overshadowed by the value of the consultant's contact work with the studios. This involves frequent telephone conversations with production personnel, visits to the studios, and trips to various outdoor locations while the scenes are actually being taken. In this personal contact work, the consultant can refine and elaborate his written forecast. For some cumulus background shots he may recommend a nearby mountain location on the following day. In another instance, it may be necessary to match the sky of some shots made a month ago — the delay of a day or two may be advised by the consultant.

Instead of setting up cameras and trusting to luck, the studio can be advised a day or

(Continued on page 39)

Record Snowcover

SNOW DEPTHS reached record proportions in the northeastern United States during the latter part of January. Cold arctic and polar continental air continued to flow southeastward from central Canada. This regime caused frequent cyclogenesis along the gulf and south Atlantic coasts. Storm after storm moved northeastward along the coastline, depositing copious amounts of snow generally from southern Virginia northward. Temperature and moisture conditions combined to lay down the heaviest cover in central and eastern Massachusetts. February was relatively dry. The table below, compiled from records by M. C. Stewart, an AWA member, at Ashburnham in north-central Massachusetts speak for themselves.

Month	Day	24-hr. Fall	Total Cover	Month	Day	24-hr. Fall	Total Cover
Nov.	13	4.0	4.0	Jan.	23	1.0	41.0
	29	0.5	0.5		25	7.0	48.0
	30	0.5	0.5	Feb.	5	2.5	41.5
Dec.	6	3.0	3.0		8	0.5	39.5
	8	2.0	4.0		12	3.0	37.0
	11	2.0	4.0		14	2.0	16.0
	24	9.0	9.0		15	0.4	14.0
	27	12.0	21.0		22	T	9.0
Jan.	2	3.0	22.0		23	1.0	10.0
	3	4.0	25.0		27	0.2	9.2
	7	3.0	26.0		28	T	9.0
	8	3.0	29.0		29	11.0	19.0
	9	1.5	30.0	Mar.	1	1.0	20.0
	10	3.0	30.0		2	0.1	20.1
	14	3.0	32.0		3	10.0	28.0
	17	0.5	32.0		4	0.1	26.1
	18	4.8	36.8		5	2.0	28.0
	19	0.5	37.0		8	1.5	22.0
	21	0.9	36.9		10	T (rain)	18.0
	22	4.1	40.0		12	6.0	20.0

John H. Conover, chief observer at Blue Hill Meteorological Observatory, 11 miles south of Boston and 640 feet above sea level, points out that with the exception of the mountainous areas of Massachusetts, Vermont, and New Hampshire, snowcovers approximately equal to the record amounts on the ground at Blue Hill existed only along a belt running southwestward from Newburyport to the Newtons. Around the base of Blue Hill, at only 200 feet elevation, and to the south and west snow amounts were less because the December storms were largely rain.

The previous maximum seasonal snowfall at Blue Hill, where the total had reached 136.0 inches by March 18th, was in 1915-16 when 111.5 inches fell. This January's maximum snowcover of 41.9 inches exceeded the 63-year record of 38.5 inches on February 25, 1920. January's total fall of 56.3 inches exceeded all other months on record, January, 1904, having had 48.0 inches.

Monthly snowfalls at Blue Hill for 1915-16 and 1947-48, with the 63-year normal amounts, are:

	Oct.	*Nov.*	*Dec.*	*Jan.*	*Feb.*
Normal	0.1	3.2	10.2	15.4	16.3
1915-16	0.0	1.0	12.3	6.4	33.4
1947-48	0.0	4.8	39.5	56.3	21.6

	Mar.	*Apr.*	*May*	*Annual*
Normal	10.0	3.3	0.1	57.3
1915-16	42.2	16.2	0.0	111.5
1947-48	13.8 to March 18th.			

AMERICAN METEOROLOGICAL SOCIETY

NOTES ON THE 97TH NATIONAL MEETING

THE CONSTANTLY widening scope of present meteorological research received emphasis at the 97th national meeting of the American Meteorological Society in New York City on January 28-30th. The 31 papers described new developments in a variety of subjects from surface synoptic analysis to theories of the ozone shadow and the gaseous composition of the upper atmosphere.

The most popular feature, as usual, was the joint session with the Institute of Aeronautical Sciences. Three papers dealing with the U. S. Weather Bureau's thunderstorm research project were presented by members of the staff. New data on the apparent cellular structure of the thunderstorm and on measurements of horizontal convergence in the vicinity of cumulonimbus received detailed treatment, and it is expected that some of this material will be available for publication in WEATHERWISE.

The General Electric team of Dr. Irving Langmuir and Vincent Schaefer announced results of recent cloud seeding efforts and of progress in the detection of "ice nuclei" in the free atmosphere. The theme of the entire meeting was sounded by Professor J. Kaplan in his timely paper, "Significance of Basic Research in the Upper Atmosphere for the Meteorologist and the Aeronautical Scientist." He enumerated the many branches of science that had special problems in the realm which once was considered the exclusive field of the meteorologist.

Abstracts of all the papers presented at the meeting may be obtained from the AMS executive secretary, and some of the papers will be published in entirety in the society's publications.

The annual dinner, arranged by the New York Meteorological Society, featured an address by Brig.-Gen. Milton W. Arnold, USA retired, former weather officer and now vice-president of operations and engineering, Air Transport Association of America. Professor A. F. Spilhaus, of New York University, served as toastmaster.

As newly elected president of the AMS, Capt. H. T. Orville, USN, succeeds Professor H. G. Houghton, of Massachusetts Institute of Technology, who guided the society through two difficult postwar years. Capt. Orville comes to his post with a long and active background in aviation and meteorology. He was born in Saratoga, Wyo., on January 16, 1901. He holds a B. S. degree from the United States Naval Academy and a degree of S. M. from M. I. T. An active balloon enthusiast, Capt. Orville has participated in international balloon races and was official observer aboard the first flight of the *Hindenburg*. During the recent war, he was Chief, Naval Aerological Service, and adviser to the commander-in-chief of the United States fleet. With a brief acceptance speech, Capt. Orville outlined ambitious plans for the further development of the society.

Professor H. G. Houghton, retiring president of AMS, congratulating Capt. H. T. Orville, USN, on his election as the new president of the society.

Other officers elected are Vice-president Jacob Bjerknes, University of California at Los Angeles; Secretary Charles F. Brooks, Blue Hill Meteorological Observatory; and Treasurer Henry DeC. Ward, of Eaton and Howard, Inc.

AMS SPRING MEETING

The American Meteorological Society will hold a spring meeting in Washington, D.C., about April 21-23, 1948. Exact dates and place of the meeting will be announced in a notice to members.

The effect of prevailing winds. Photo by James Horne II, from *The Elements Rage*, by Frank W. Lane.

MARCH OR OTHERWISE

D. C. CAMERON

THE DICTIONARY defines wind as "air in motion" or "a natural current of air." In the science of weather, however, wind is considered only that portion of the air in motion that is flowing horizontally — any up or down motion being termed an air current.

But any of us who have been out in a piercing winter wind knows how penetrating it can be, or how exhilerating, depending, of course, on our mission in the wind. In our country, as in other parts of the world, winds are known locally by distinctive names. Southern California has its "Santa Ana," the warm, dry descending air from the desert interior; western Oregon the moist southwesterly winds of winter; while the true chinook or foehn wind of our West is the descending westerly wind from the Rockies — warm and dry, that blows principally in Montana, Wyoming, eastern Colorado and portions of the western Dakotas. Texas has its "norther," the southward rush of polar or arctic air that can change summer into winter almost in one gust. The southern plains have their "dusters," while farther north the best-known (and feared) wind is the northwest "blizzard" of the Dakotas. Along the Atlantic seaboard, there are the general cyclonic storms known as "nor'easter" and "sou'wester," as well as the more sudden and violent "sou'easter." All these winds are stories in themselves, but here we are concerned with wind in general.

The speed of the wind is measured by an instrument known as the anemometer, of which there are several varieties: rotation (cup), pressure plate, bridled, pressure tube, and propeller. At very high velocities, however, the traditional types have proven unserviceable, but recent research in connection with wind-tunnel experiments have developed new types of wind-measuring equipment which may be applied to the meteorological field. The weatherman's embarrassment when his instruments blew away on the day of the "big wind" should be a thing of the past.

The windiest month.

March winds have long been famous in poem and story, but over about one half of this country March is not the windiest month. April taking the honors in nearly all of the Plains and Rocky Mountain areas (Fig. 1). A variety of winter months assume the title in the Great Lakes and New England. March is easily in the lead over nearly all of the eastern half of the country. In the far West the month varies widely from December to July. Only on parts of the Pacific coast are summer winds the strongest, and anyone who has stood exposed to the stream of marine air rushing landward through the Golden Gate at San Francisco in July, will attest to its strength and chilliness! Nowhere in the country does August, September, or October appear as the windiest month.

The windy city?

Any radio quiz show can be sure of an answer to this one, but is it correct to apply the term to Chicago? According to official wind records it most certainly is not! Some say Buffalo is windiest, but this distinction does not apply to any eastern city. Chicago came to be known as "the windy city" back in the "gay '90's" when the wind records were made

The windiest month. From Weather Bureau records.

on top of the Auditorium Building on Michigan Boulevard, 274 feet above the ground. There were no other high buildings to obstruct the free flow of the wind, and during the 15-year period (1890-1905) the average hourly speed was 17 m.p.h., easily the record for the country. All the highest wind records for every month were set during this period, and they still stand unchallenged by subsequent measurements at lower exposures.

It is only fair to state that any lake region city with instruments comparably exposed would match this record made at Chicago, but the latter's reputation has stuck for half a century. Buffalo had a comparable exposure for many years on the telephone building close to Lake Erie, and the speed now shown as the 51-year average is 14½ m.p.h., the highest in the lakes region.

Wind exposure and the national average.

The exposure of the anemometer means everything in any comparison of wind speeds, so it is unfair to judge any city as the "windiest" on the basis of the wide variation in exposures now existing. One encouraging development, however, is the recent movement of wind recorders away from city roofs to airport ground exposures. It has been claimed that a truly representative wind speed can be obtained about 50 feet above the ground and free of all obstructions. This is obtained at most airports where many instruments are located either on beacon towers or administration building roofs, free of local interference and close to the 50-foot level.

The 1946 average hourly wind speeds show that 10 m.p.h. is about the United States mean. The greatest expanse of really windy country is the vast stretch of treeless plains from Oklahoma and northern Texas northward and northwestward into the Canadian prairie provinces. Over a wide area in Texas, Oklahoma, and Kansas the 1946 average (annual figures vary but slightly from year to year) was 15 m.p.h. or higher, and the windiest spot of all was the Dodge City, Kans., airport with 17 m.p.h. (same as Chicago's record on the Auditorium Bldg.). Anyone who has done much traveling along U. S. Route 66 through Oklahoma and the Texas panhandle can testify to the general windiness of that country. Perhaps Amarillo would care to claim Chicago's title?

The coastal strip from southern New England to Hatteras, plus Miami, and the Texas gulf coast averages above 10 m.p.h., but on the Pacific coast only the exposed headlands (North Head, Ore., and Tatoosh Island, Wash.) show high averages. Other points farther south, such as Cape Mendocino and Point Reyes, Calif., are notoriously windy, especially the latter when the summer sea breeze becomes well established.

Least windy spot on the weather map is Roseburg, Ore., averaging a gentle four miles per hour, but here again is the case of a sheltered community keeping a record, while

Average wind speeds for 1946. The shading indicates regions of 10 miles per hour or stronger.

hundreds of similarly situated valley points are without records but may have even less wind than Roseburg, especially in the western mountains.

New Hampshire has the distinction of having the windiest anemometer exposure in the United States. Atop the 6,293-ft. peak of Mt. Washington are an array of wind instruments gathering data for many research projects. One spring day produced the highest wind speed ever measured by man at the earth's surface, when a sustained gust of 231 m.p.h. was recorded on April 12, 1934.

Several recent developments point to improvement in wind records. The movement of instruments to airport locations will help to eliminate unequal exposures. The replacement of the former five-minute sustained speed reporting period by one-minute periods gives better representation of peak winds. Finally, the post-war introduction of the new types of anemometer gives a continuous recording of gusts and lulls so important to the aviator.

WEATHER BY STARLIGHT

ERIC SLOANE

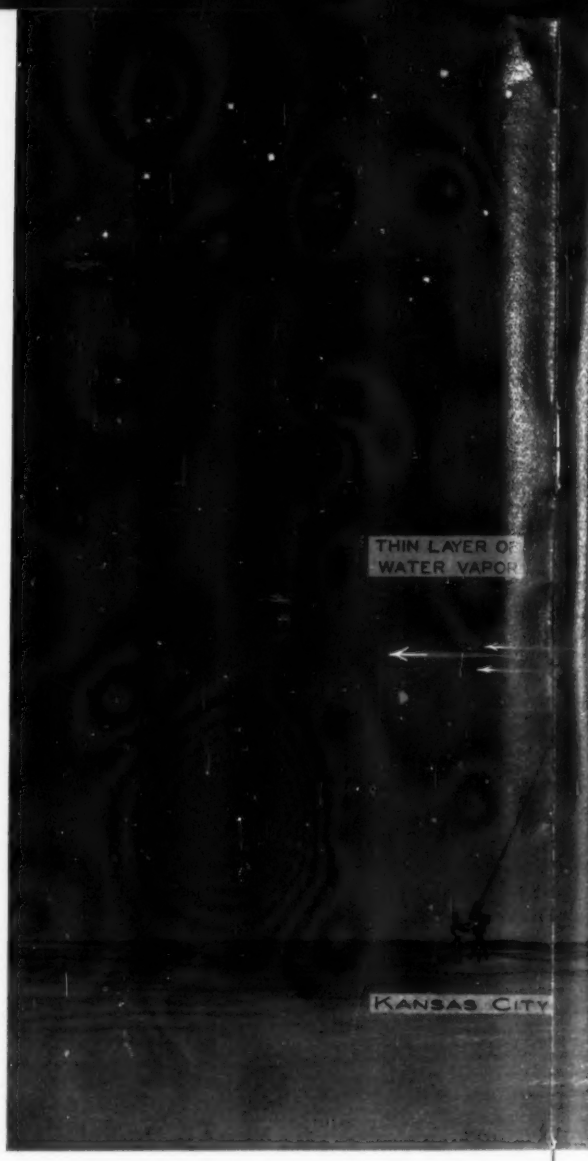
ILLUSTRATED BY THE AUTHOR

WHEN ASTRONOMERS perfected instruments to measure the light of distant stars, they unknowingly invented what may prove to be an important link in the quest for improving weather forecasts. Hitherto all weather analysis of the atmosphere aloft has been accomplished by releasing hundreds of radiosonde balloons as high as they will go, each sending reports as it ascends. Now an instantaneous ground-recorder seems possible — meet the "water-vapor spectroscope."

Before a star's light reaches a light-recording instrument, it must pierce the earth's layer of atmosphere, the starlight being affected by the amount of water vapor and other constituents of the air. Measurement of the star's radiation in certain wave lengths results in a determination of the amount of moisture and potential rainwater overhead. One might think that such an instrument could only be used at night, but the newest apparatus readily detects bright stars in broad daylight. U. S. Weather Bureau scientists hope that a new technique, using telescopes and infrared detectors, may give a 24-hour system of keeping track of the atmosphere's most important weather ingredient, its water vapor.

Dr. John S. Hall, astronomer at Amherst College, uses either a photomultiplier tube or an infrared-sensitive lead sulfide cell to make observations of the intensity of starlight. The photomultiplier is a tube which can amplify light energy a millionfold, while the lead sulfide cell is sensitive to infrared wave lengths as long as two microns. This latter cell was at the heart of the wartime snooperscope and other infrared devices which permitted our troops to see in the dark.

Water vapor in the air causes strong absorption bands in the infrared portion of a star's spectrum. Thus, the energy of a star in a spectral region where water-vapor absorption is heavy can be compared with the energy from the same star in another spectral region. This comparison gives us a measure of the water vapor present in the atmosphere in the vicinity of the observer.



Such comparisons can now be made using sunlight. The rapidly changing altitude of the sun complicates the reduction of the observations considerably, and plans are now being carried out at Amherst College for observing the Pole Star continuously day and night. Since Polaris is always within a degree of the north celestial pole, its position rela-

tive to the observer and the horizon is nearly fixed and reduction of the data should be extremely simple.

As many as 10 years ago, Dr. Hall compared the energy from different stars in different spectral regions with a photoelectric spectrophotometer, and clouds of invisible water vapor were very conspicuous in that they interrupted his observations. The intensity of the light from each star was proportional to the velocity at which a very small electrometer needle crossed the field of a microscope. If a cumulus cloud passed, the needle would stop until the sky was clear in the direction of the star. During observations in the spectral region of the water-vapor bands, it was sometimes evident that this same phenomenon was happening even though no clouds were visible — the needle would suddenly stop and then after a few seconds, perhaps even a minute, would continue on its path. This erratic motion was not evident when observing in other spectral regions on the same night.

Amateur Weathermen of America

Amateur Weathermen of America comprises an association of all followers of the ways of the weather. Its purpose is to enlarge our understanding of weather and climate and to apply this information for the greater enjoyment of life. The Amateur Weathermen is an agency for the exchange of information, both technical and popular, among all interested individuals and groups. It is especially concerned with all projects that will enlarge the scientific outlook of the youth of America. All who enjoy studying any aspect of weather phenomena are eligible for membership and participation in its activities. Write to David M. Ludlum, Director, AWA, Franklin Institute, Philadelphia 3, Pa.

WEATHERWATCH

A monthly summary of weather events is now being issued to all regular members of the AWA. It is appearing under the tentative title of *Weatherwatch* and in a temporary format. It is hoped that the publication can soon be enlarged to contain an actual map with pictograph representation of the interesting weather events of the past month. *Weatherwatch* is issued early each month, and draws data from published weather reports, maps, and newspaper data. AWA members in each state are urged to prepare and distribute a similar local publication for members in their vicinity.

RADIOSONDES

The Weather Bureau has given the AWA 50 reconditioned radiosondes for distribution to schools and colleges. The instruments are complete with temperature and humidity elements and batteries. Radiosondes for use in school educational work may be obtained by writing the AWA on official school stationery. Please enclose one dollar to cover packing and mailing costs.

CAMP COUNCILLORS

Several requests from camp directors have recently been received for recommendations for summer camp jobs as nature councillors. Applicants should be able to inaugurate a weather program at a camp as well as to carry on other duties in nature study and general camp work. Interested persons should write the AWA and state all qualifications and experience.

PHOTOGRAPHY CONTEST

Amateur Weathermen of America announces a bimonthly contest for photographs with a weatherwise theme. Although cloud pictures will be considered, shots of weather at work or of people doing something about the weather are desired. Winning photos will be published in WEATHERWISE. Send your entries to AWA and enclose postage if you wish them returned.

MT. WASHINGTON

The first summer meeting of the AWA will take place at Mt. Washington, N. H., on July 6, 1948. The theme of the session will be weather and camping. Several prominent meteorologists will be present to give talks and demonstrations; details will be published here in June. All AWA members, and camp directors and councillors are invited to attend.

FROST STUDY

Amateur Weathermen of America are requested to make notes on frost formation in their vicinities commencing April 1st. The date and intensity of frost should be recorded, and biweekly reports mailed on a postcard to the AWA on the 1st and 16th of the month. No regular forms will be distributed. These observations will greatly assist in the preparation of *Weatherwatch*.

Note first the intensity of frost, whether light, moderate, heavy, or killing. The date of the last killing frost is exceptionally important as it determines the length of the local growing season. The extent of the frost and the type of surface on which it forms should be noted. Keep minimum temperature readings if a properly exposed minimum thermometer is available. The type and configuration of the frost formation is important. Little research has been done in this field, and here is an opportunity to start a microclimatological study that will be of great benefit to local industries.

THE Bendix *Air-Marine Portable* Radio

Product of
Bendix Aviation Corporation

brings air range voice weather reports for your locality every half hour!

Official C.A.A. Reports, the weather information that guides the airlines, can be yours with the Bendix Air-Marine Portable. Every half hour, day or night, just turn the knob from the standard broadcast band to range frequency for readings on visibility, ceiling, sky conditions, obstructions to visibility, precipitation, temperature, dewpoint, and wind. Winds aloft observations are also broadcast four times a day as well as 2-hour interval weather forecasts. Get clear *voice reports* of all the weather conditions in your area, as well as regular entertainment programs, with the Bendix Air-Marine Portable, at only $89.50 less batteries, operating on A.C.-D.C. current or batteries (slightly higher in western states).

BENDIX RADIO

BENDIX RADIO DIVISION of
BALTIMORE 4, MARYLAND

Bendix
AVIATION CORPORATION

FORECASTING THE WEATHER

East Coast Storms

JAMES E. MILLER
COLLEGE OF ENGINEERING, NEW YORK UNIVERSITY

ON THE MORNING of last December 26th, the box in the upper right-hand corner of the front page of the New York **Times** contained the prosaic forecast, "Snow, ending during this afternoon. Fair tomorrow." The weather summary on page 31 stated, "There will be little precipitation in the country today," and the weather map on the same page showed that an unimpressive cyclone had been centered south of Cape Hatteras the afternoon before, possibly the source of the expected light snow.

That afternoon a black, four-column headline in the New York **Sun** informed an already well-informed public: HEAVY SNOWSTORM DELAYS THOUSANDS. When that edition of the **Sun** went to press, only six to eight inches of snowfall was expected; but by the time the snow ended in the evening a total of 25.8 inches had been measured at the Weather Bureau office at Battery Place, on the southern tip of Manhattan Island. Suburban points within a radius of about 20 miles of New York Bay all reported depths close to 30 inches.

The famous blizzard of '88 had produced, in a period of three days, only 21 inches of snow in New York City. The "blizzard of '47" — as it is already coming to be known though it was not technically a blizzard — piled up its 25.8 inches in less than 24 hours. Traffic was brought almost completely to a standstill; automobiles, trucks, and busses were stalled at all angles in the streets and half buried by drifted snow. The fire commissioner broadcast a warning that the city faced its greatest fire hazard in history because of the impossibility of moving fire apparatus through the clogged streets. An additional three million dollars was appropriated to dig the city from under the paralyzing white blanket. The Weather Bureau estimated that 99 million tons of snow lay on the city; some 30,000 men labored to clear it off streets and sidewalks.

The genesis of this storm and its deceptively rapid development were characteristic of type B East Coast storms in winter. This type of storm may be expected to form somewhere near Cape Hatteras or Chesapeake Bay when there is a low pressure system in the Great Lakes area, a high pressure wedge oriented northeast-southwest in New England, and southwesterly winds aloft along the East Coast. The example in Figs. 1 and 4 exhibits some of the characteristics of type B cyclones in their most typical form.* The storm of December 26th resembled the prototype closely, its most obvious difference being the unusually heavy snowfall. No more than a few inches of snow from a type B cyclone would normally be expected at New York.

Because of their rapid development, type B storms are a particularly baffling problem for the forecaster. There are two precursory signs of their genesis: the spreading of middle clouds and precipitation over the East Coast area (more extensively than would be expected from the primary cyclone in the Great Lakes area); and the sudden appearance of a localized area of falling pressure separated from the pressure falls ahead of the primary cyclone. The speed of these developments is a clue to the speed of formation of the new cyclone. But it is no more than a clue — exact methods of forecasting the

*Figs. 1 to 4 are from "Cyclogenesis in the Atlantic Coastal Region of the United States," James E. Miller, **Journal of Meteorology**, Vol. 3, 31-44, June, 1946, in which further details of the characteristics of East Coast storms can be found.

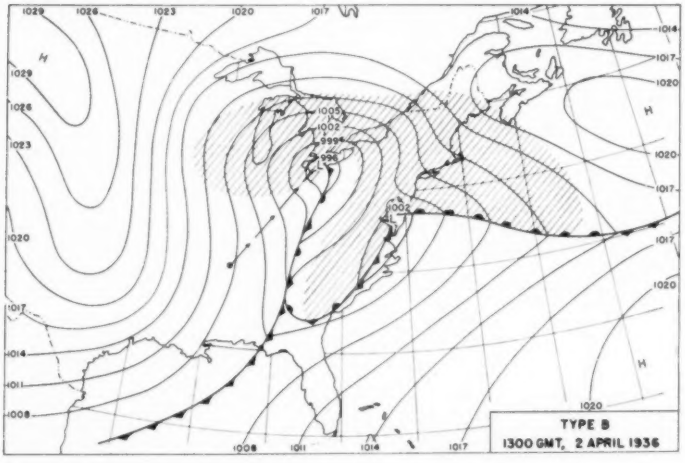


Fig. 1. Example of a type B cyclone at the time of origin. Fronts are indicated by the conventional symbols. Areas where precipitation is occurring are covered by hatching. Twenty-four-hour positions of pressure centers are marked by a cross in a circle.

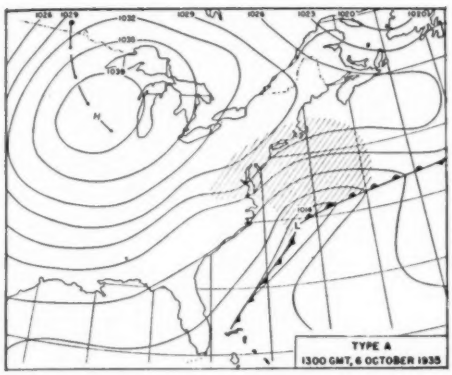


Fig. 2. Type A cyclone at the time of origin.

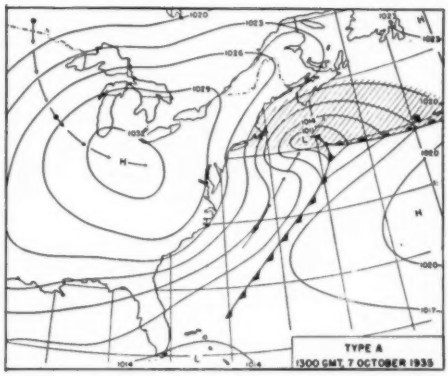


Fig. 3. Type A cyclone 24 hours after time of origin.

deepening and strengthening of Atlantic coastal storms have not been found.

Once formed, the new cyclone will usually move with the upper winds near the 10,000-foot level. If these winds are steady, the motion of the cyclone can be forecast with good accuracy. If upper winds are backing, as is sometimes the case, the storm's trajectory will be more toward the north, and hence its effect along the middle coast will be greater than if it moved along the typical northeastward track.

Type A storms (Figs. 2 and 3) may originate when there is a cold anticyclone covering most of the eastern United States. The polar-continental air in the area of the anticyclone is bounded in the coastal region by a cold front in which a wavelike deformation appears. The retardation of part of the southward moving cold air, creating the frontal wave, may be caused by the Appalachian Mountains or by inequalities in the air flow. The new cyclone forms at the peak of the frontal wave. This type of storm begins most frequently over the Gulf Stream in latitudes 30° to 35° north, off the Carolina and Georgia coasts.

Of the two general types of East Coast storm, type B is more frequent than type A; it generally originates nearer the coastline; and it has greater influence on the coastal weather. The monthly precipitation in New York and other seaports is about as great in winter as in summer largely because of the precipitation from type B storms.

East Coast storms of the winter season originate in the frontal zone of convergence between the warm, moist, tropical-maritime air masses over the Gulf Stream, and the cold, dry, polar-continental air masses that invade the eastern United States from the snow-covered expanse of Canada. There is no generally accepted theory to explain how a low pressure center forms in the zone of convergence; but, once the center appears, the convergence of the contrasting air masses is increased by the force of the pressure gradient, the converging streams of air acquire a

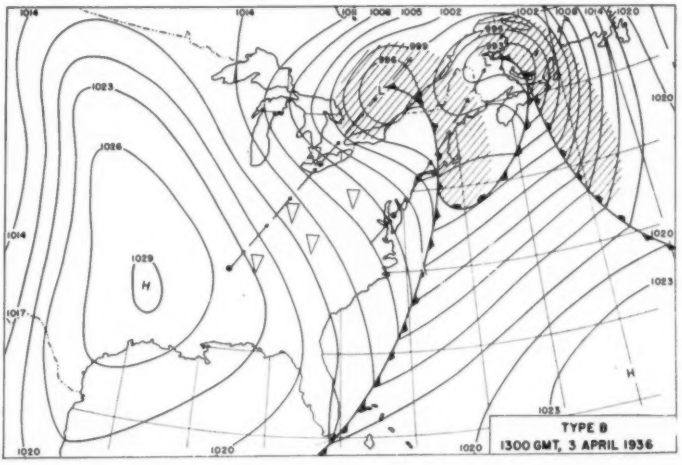


Fig. 4. Type B cyclone 24 hours after time of origin. Notice how secondary low pressure area has moved northeastward at a greater rate than the original storm center. Of interest also is the rapid southward movement of the west-central high pressure center.

counterclockwise circulation as a result of the earth's rotation, and the cyclone is born.

The inward moving air currents force the air in the central zone of the cyclone to rise. The air pressure normally decreases upward very rapidly. In a quarter-mile vertical distance it decreases about 45 millibars, as much as it decreases in a horizontal distance of 500 miles from the periphery to the center of a deep cyclone. Consequently, as the air ascends to lower and lower pressure, it expands and cools past its dew point. The water vapor it contains is condensed into clouds, and the cloud droplets coalesce into rain, snow, sleet, or possibly hail, depending on the vertical distribution of temperature and the small-scale, turbulent air currents.

A study and cataloguing of all East Coast storms in the months of October to April, 1929 to 1939, revealed that there are nearly 21 storms per season, although the number in individual seasons may vary from 10 to 28. December and March are the months of greatest frequency, each with an average of slightly less than four. Type A cyclones are most frequent in November, and type B in January.

Cyclogenesis is a common wintertime phenomenon on other east coasts as well as that of North America. In the vicinity of the Japanese Islands and Formosa, the zone of convergence between air masses warmed by the Japanese Current and polar-continental air from eastern Siberia is a prolific source of new cyclones in winter. The frequency of cyclogenesis in this region is even greater than in the eastern United States. The cyclones that form there do not, however, fall conveniently into the A and B classifications, because their mode of formation differs with the different topographic influences. Cyclones form in similar conditions on the east coasts of South America, Australia, and Greenland.

To predict the future wind, weather, temperature, ceiling, visibility, and total precipitation that will be associated with a rapidly developing cyclone requires the utmost skill of a forecaster. When the cyclone is no more than a weak low pressure center at the time the forecast is issued, the forecaster must call heavily on his experience and intuition. Statistical studies of east coast storms strongly point to the fact that no simple solution to the problem lies hidden somewhere for an astute researcher to discover. In all probability there will be many years of painstaking research, both experimental and theoretical, before a forecaster can deal confidently with one of these storms.

The Early March Cold

THE WINTER OF 1947-48, already in ill repute in many sections of the nation, staged a series of encores in early March that sent the people and the records staggering.

On March 5th the winter's highest pressure (Buffalo, 1051 millibars, 31.04", all-time high) sent temperatures in upstate New York and northern New England to record March lows. At Canton, N. Y. it was −28° on the 4th, a new late season low, but two degrees short of the March record set in 1938. When cold air from the high had first pressed along the east slope of the Rocky Mountains, it was overrun by Pacific maritime air, which resulted in general heavy snow over the entire wheat belt from eastern Colorado and New Mexico into Texas, Oklahoma, and Kansas. Thereafter, clearing skies, slackening wind, and fresh snowcover were the optimum for intense nocturnal radiation, and there followed three to four mornings with subzero readings, such as −20° at Pueblo on the 5th, breaking a 1922 March low by seven degrees.

The final morning of this condition, March 8th, saw the stage set for the worst onslaught of all, as a new polar air mass started south out of western Canada and a low formed along the continental divide in Idaho and Wyoming. As the high built up over the Canadian plains, the cold intensified and once again pressed westward against the Rockies. Overrunning maritime air resulted in widespread heavy snow that reached blizzard proportions by the night of the 9-10th, as the low swung down the Rio Grande valley. Farther north, in Montana, the Dakotas, and the prairie provinces under the dome of the high (1040 millibars, 30.70"), intensely cold air continued to feed down, to establish record minimum temperatures. As the high pressed slowly southeastward, the clearing weather behind the snow brought these conditions in a narrowing wedge deep into Texas and eastward in a still narrower band into Illinois, Indiana, Ohio, and upstate New York.

Preliminary data gleaned from the daily weather map and the nation's press reveal that many a city's former minimum record has been replaced. A new March low and the minimum for the current winter occurred at Butte with −36°; Fargo, −34°; Duluth, −30°; Des Moines, −12°; Dodge City, −15°; Las Vegas, N. M., −16°; Amarillo, −3°; Tulsa, −3°; and Springfield, Ill., −8°.

A March record, but not the winter's low, was set at Lincoln with −14°; Sioux City, −19°; San Antonio, +21°; Kansas City, −3°; St. Louis, +1°; Indianapolis, −5°; Cleveland, −5°; Canton, Ohio, −14°; and Syracuse, −10°.

In addition, state-wide March lows were set in Kansas by −23° at Hays (previously −21° in 1920); Iowa by −30° at Sibley (−24° in 1890); and in Arkansas by −12° at Bentonville (−6° in 1943).

The lowest temperature reported was −42° at Cass Lake, Minn., on March 10th. Unofficial readings of −54° at Elk Park and −45° at Georgetown Lake, both near Butte, Mont., indicate that the country's all-time March low of −50° at Snake River Ranger Station, Wyo., on March 17, 1906, may be surpassed. D. C. C.

REMARKS ON LONG RANGE WEATHER FORECASTING

(Continued from page 26)

hind troughs and heavy ahead of them, while ridges are generally characterized by little precipitation, especially on their forward sides. The chart already mentioned shows the temperature anomalies observed with a ridge and trough system of large amplitude over North America. This illustrates the importance of a long fetch of Arctic air into the eastern United States, leading to a cold wave (characteristic of late January and early February of this year).

Finally, an attempt is made to forecast the weather maps day by day for six days ahead. These prognostic charts are constructed principally from the lines of action suggested by the mean circulation prognoses. The daily series must start off in a reasonable manner from the 24-hour prognosis, be logically consistent as to continuity from chart to chart, and make up the mean chart in a consistent manner, that is, they must average out to make the mean state forecast and must follow the lines of activity suggested by the mean charts.

The timing of weather sequences in a weekly period is by far the most elusive part of this or any long range forecasting technique. While the general characteristics of a period and broad trends of weather within the coming week may be forecast with reasonable skill, a forecast of weather for any specific day beyond three days in advance is apt to meet with little success. This state of affairs has often led to a misunderstanding of long range forecasting methods and the possible uses of the forecasts. While the play-by-play, day-by-day description of weather is undeniably important, there is considerable economic usefulness for forecasts of average conditions and trends. Farmers and hydrologists are often not especially interested in exactly when a heavy rainfall will occur but rather how much rain will fall over the coming five-day period. Similarly, the fuel co-ordinator is not as interested in whether it will be warmer next Thursday as he is in whether the coming week will average 10 degrees below normal.

As forecasts become concerned with periods longer than a week, the problems become more complex and the entire subject more and more speculative. For this reason an elementary discussion of the status of this problem appears premature.

REFERENCES

C.-G. Rossby, *The Scientific Basis of Modern Meteorology, Climate and Man*, Yearbook of Agriculture, U. S. Department of Agriculture, 1941.

Namias, Jerome, *Extended Forecasting by Mean Circulation Methods*, U. S. Weather Bureau, February 1947. (Contains an extensive list of references on the particular method treated in this article.)

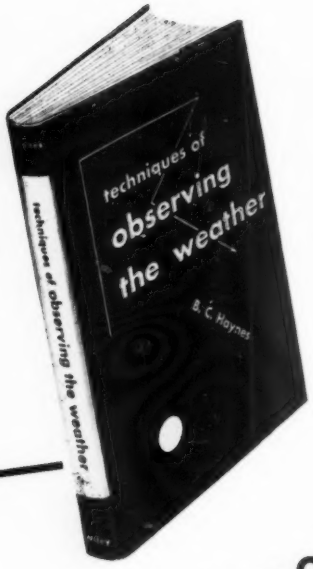
Department of Meteorology, California Institute of Technology, *Synoptic Weather Types of North America*, December 1943.

GLAMOUR COMES TO THE METEOROLOGIST

(Continued from page 28)

so in advance when a colorful sunset is in prospect. Perhaps three days are required to take one scene of a period picture (with all the actresses in long full dresses and plumed hats), and any wind causing the costumes to flutter will make matching of various sections of the sequence virtually impossible. Will the wind remain light for the next three days? The consultant assures the production manager that it will. If an ocean storm sequence is required there must still be sufficient light for filming. The studio is advised before the storm strikes, and the forecast is checked on an hour-to-hour basis as the cloudiness begins to break after the storm's passage.

One of the most important functions the consultant performs is that of adviser on distant locations. In the middle of April, for example, will photographic weather be better at Las Vegas or at Phoenix? Or, Las Vegas having been decided upon, will the weather there be better in April or May? To answer questions like these, cloudiness statistics are interpreted in terms of photographic good shooting days. In spring, because of the local haze condition, a clear day in Los Angeles is not equivalent photographically to a clear day in Palmdale, only a few miles away. Nor is a good shooting day for one studio necessarily the same as for another, since one may desire cloudiness and rain for a picture dealing with the Irish moors, while another may need excellent light and a "bald" or cloudless sky for a sequence laid in Arabia. Each is an individual problem which the meteorologist is most qualified to solve.



How to collect accurate weather data

TECHNIQUES OF OBSERVING THE WEATHER

By BENARTHUR C. HAYNES

Chief, Observation Section,
U. S. Weather Bureau

A practical book that tells you exactly how to gather the data that is necessary for predicting the weather. The author treats means and methods of observation thoroughly, and gives detailed instructions on the use of instruments, charts and forms.

Technical details are explained simply and clearly. Sections that require exact definitions follow the official international wording used by the United States Weather Bureau.

Contents include: The Atmosphere; The Weather Observatory; Clouds; Visibility; Hydrometers; Temperature; Humidity; Wind; Pressure; Precipitation; Winds-Aloft Observation; Electronic Meteorological Observations; An Improvised Weather Station.

1947 **272 pages** **$4.00**

Copies obtainable on approval.

JOHN WILEY & SONS, INC.
440 Fourth Ave., New York 16, N. Y.

TRAINING AIDS FOR WARM, COLD, AND OCCLUDED FRONTS

SEVERAL BOOKS AND DEVICES are at hand which emphasize and aid considerably the study of fronts of all kinds. Our brief remarks concerning them will enable the reader to evaluate to some extent their use in particular studies and training programs.

Meteorology Work Book, with problems, by Peter E. Kraught, was published in 1943 by Cornell Maritime Press, New York. It has 148 pages, 141 illustrations, many other charts and cloud pictures; $2.25. It is an excellent and well-prepared book for beginners in weather training. Its general discussions and well-illustrated problems simplify a few of the more technical phases relating to charts and diagrams. The resulting concise picture is very essential to rapid advance in weather knowledge.

Chapters I through XII bring the student along step by step toward the more basic understanding of the elements in relation to fronts and frontal weather. In the next chapter four kinds of fronts are discussed in detail; stationary fronts are well defined and made much easier for the student to locate relative to similarity of the structures involved. There are illustrations of the different slopes of frontal surfaces, and the temperatures and winds associated with them are properly explained. The illustrations showing the clouds and weather in conjunction with the different types of fronts are logically described.

Realm of Flight is a small book prepared by George Sidney Stanton, Civil Aeronautics Administration, to aid pilots in visualizing weather. Its 41 pages include some magnificent examples of warm, cold, and occluded fronts. All the 32 illustrations are in proper colors, which adds to their appearance and effect. This book will help the student to remember and understand more thoroughly some of the complicated problems of circulation. It is for sale by the Superintendent of Documents, Washington 25, D. C., for 60 cents.

Three-Dimensional Weather Maps, Device No. 12-k-2-a, U. S. Navy Department, prepared by the Office of Chief of Naval Operations, is a set of three maps for pilots who have difficulty in visualizing the vertical structure of large cyclonic storms. The three-dimensional models are made of durable cardboard. They illustrate a typical cyclonic storm in the earlier stages of development, and in the more advanced stages of warm-front and cold-front type occlusions. The base map of each model represents an area 800 by 1,000 miles, and shows weather information at the earth's surface in the same manner as a synoptic map. Attached to each map are eight sections which move to a vertical position when the model is opened. These upright plates show frontal surfaces, air mass movements, cloud structures, and precipitation, all to an altitude of approximately 25,000 feet. Explanatory notes beside the vertical plates and on the facing pages aid individual study. Available for $3.75 through dealers, these maps make an excellent training aid in cyclonic storms and their weather phenomena.

Workbook in Elementary Meteorology. To enable the student to understand many weather fundamentals which fail to be thoroughly explained in textbooks, Frederick L. Caudle has written this 191-page workbook, published by McGraw-Hill Book Company, Inc., in 1945; $1.24. The descriptive methods relative to warm and cold fronts are not too thorough. This is offset, however, by some station model exercises to give the very elementary student excellent practice in learning to locate the fronts for himself.

Moving Weather, Parts I and II. This combination of text and workbook is one of the best training aids in relation to different types of fronts, elementary weather training, and pilot training. It is one of the subjects in pilot training which appears in the Graphic Flight Series, and is written by Russell R. Spafford, Tennessee Flight Operators Association, Clarksville, Tenn. The process used in "moving the weather" is highly commendable. A thin piece of tracing paper with a typical frontal situation can be moved over regular weather maps to illustrate frontal development.

A. L. McCUISTION
Spartan School of Aeronautics

BOOKS RECEIVED

Tropical and Equatorial Meteorology, by Maurice A. Garbell. Pitman Publishing Corp., New York, 1947. 238 pages. $10.00.

Meteorology for Airmen, by Charles A. Zweng. Pan-American Navigation Service, North Hollywood, Calif., revised 1947. 321 pages. $3.00.

Thunderstorm Rainfall, Hydrometeorological Report No. 5, by Hydrometeorological Section, Office of the Hydrologic Director. Waterways Experiment Station, Vicksburg, Miss., 1947. Two parts, 331 pages. No price available.

THREE EXCEPTIONAL CITIES

Tacoma, Wash., Tampa and Miami, Fla., are the only three major cities where temperatures of 100° F. or 0° F. have never been recorded. Seattle, formerly of this distinction, passed from the group in July, 1941, when the temperature reached 100°.

WORKSHOP FOR WEATHERMEN

CONDUCTED BY CHARLES A. LAIRD

How to Construct a Practical Rain Gauge

ACCURATE MEASUREMENT of precipitation is an important part of meteorology. The simplest rain gauge is a straight-sided tin can in which rainfall may be measured by a ruler. Rainfall, however, is normally measured to hundredths of an inch, and such fine measurement would be difficult with a plain container of this type.

A practical rain gauge is constructed so the water to be measured is a multiple of the precipitation that has actually fallen. For example, if rain fell into a funnel, and through that funnel into a tube whose area at either end equalled 1/10 that of the funnel mouth, 0.01″ of rain would measure 0.1″ in the tube, and such an amount could be measured accurately with an ordinary ruler.

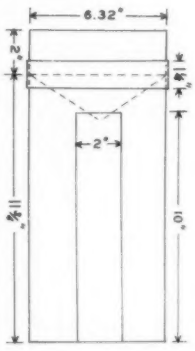
The standard rain gauge of the Weather Bureau has a funnel 8″ in diameter with a rim about 2″ high put around the mouth of this funnel to prevent the water from splashing out. The precipitation flows into a measuring tube with 1/10 the area of the mouth of the funnel and is measured by inserting a thin ruler, divided into inches and tenths, into the tube to determine the height of the water. The result is then divided by 10 to get the actual rainfall. Therefore, 10″ of water in the rain gauge would mean 1″ of rain had fallen.

The amateur weatherman can construct a reasonably accurate rain gauge in the manner shown in the drawing. The measuring tube in this rain gauge is 2″ in diameter and 10″ in length, inside measurements. It may be constructed from standard 2″ brass tubing or made of sheet metal. A 2″ disk of metal should be soldered to the bottom. The funnel must have a diameter at the mouth or large end of 6.32″, and this is topped by a rim 2″ high with the same diameter. Since the upper edge of the rim determines the amount of precipitation that falls into the gauge, its dimensions must be accurate. This rim may be made of a strip of sheet metal 2″ wide and 19.85″ long. About half an inch or more should be allowed for overlap for soldering. Better results could be obtained by having this rim turned on a lathe from brass tube stock. The top outside edge should be bevelled at about a 45-degree angle to eliminate any flat surface from which rain might splash into the gauge.

The funnel can be purchased from any hardware store, cut down to fit the rim, and then soldered to the bottom of the rim. It may also be constructed of sheet metal. The outer container of the gauge should also have an inside diameter of 6.32″. The one shown is 11¾″ high, although this height may be varied to fit the type of funnel that is used. A strip of sheet metal 1¼″ wide is soldered to the outside of the rim, as shown in the drawing. It extends down about half its width so that the funnel and rim assembly will fit over the outside container.

A thin ruler, marked in inches and tenths, may be used for measuring the water in the 2″ tube.

If a less elaborate gauge is desired, accurate results may still be obtained by using the same type of measuring tube and the outer container only. The container alone is exposed to the weather and its contents poured into the tube for measuring after each period of precipitation.



The dimensions of the rain gauge.

When the temperature is below freezing or expected to be below freezing, and there is possibility of snow, the container only is exposed and the snow it catches melted by bringing the container into a warm room. The liquid contents may then be poured into the measuring tube.

The standard Weather Bureau rain gauge is usually mounted on a metal tripod or wood support. The gauge described here may be mounted by using four stakes driven into the ground far enough apart so the gauge fits into them snugly. A rain gauge should be exposed far enough from trees or building so they will offer no obstruction.

Weather Exchange

Classified advertisements for this column are 8 cents a word, including address; minimum ad 20 words. Remittance must accompany orders. Write Weatherwise, AWA, The Franklin Institute, Phila. 3, Pa.

FOR SALE: Friez triple register to record wind direction and speed, duration of sunshine, and duration and amount of rainfall. Excellent condition. Best offer accepted. Box 21, Weatherwise.

FOR SALE: Standard Weather Bureau rain gauge, complete, excellent condition, copper and brass construction. Best offer. Woodwind, Rydal, Pa.

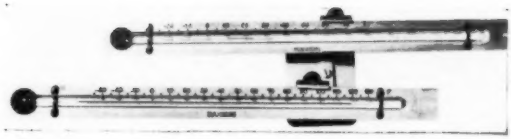
FOR SALE: Theodolite, Gurley No. 4520. Never been used, in original cartons. Guaranteed satisfactory. Complete with tripod. List $600. Will sell for $350. Box 22, Weatherwise.

FOR SALE: Biram anemometer (German), high-quality construction; similar to "Davis instrument," excellent operating condition; three-inch fan. $25.00. Herbert Basili, 35-05 30th St., Astoria 1, L. I., N. Y.

Standard U. S. Weather Bureau Instruments

PRESSURE

Aneroid barometer, USWB type. Best quality, temperature compensated movement. 5″ open center, silvered dial. Scale graduated in both inches and millibars. Also available for high elevation at extra cost. **$30.00**



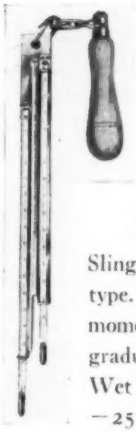
TEMPERATURE

ABOVE: Maximum - minimum thermometers, USWB type. Range: mercury filled maximum −39° to +130° F., alcohol filled minimum −50° to +120° F. Graduations etched on stem. Metal Townsend support for correct position and easy resetting. **$22.50**

LEFT: Standard mercurial thermometer, USWB type. Range −40° to +130° F. One degree graduations etched on 11″ stem. Stainless steel back and brass support. Also available with easy-reading red spirits. **$3.95**

PRECIPITATION

Rain and snow gauge, USWB type. 8″ diameter funnel, inner brass measuring tube, copper overflow can 24″ deep, and red cedar measuring stick. 20″ rainfall capacity. Iron tripod support extra. **$22.50**



HUMIDITY

Sling psychrometer, USWB type. Two matched thermometers with one-degree graduations etched on stem. Wet and dry bulb range: −25° to +125° F. Complete with muslin sock and psychrometric tables. **$8.80**

All prices f.o.b. Philadelphia. Please send check or money order for immediate shipment. Add 25 cents per instrument for shipments east of the Mississippi River; 50 cents per instrument for shipments west of the Mississippi River for insured parcel post.

SCIENCE ASSOCIATES

Everything for the study and practice of Weather, professional and amateur. Write for catalog.

401 North Broad Street, Philadelphia 8, Pa.

The new BENDIX-FRIEZ Catalogue of Meteorological Instruments is now available

Because Bendix-Friez is the most widely experienced designer and builder of meteorological instruments, this handsomely illustrated, 48-page catalogue of its products is a compendium of the latest advancements in this highly specialized field.

WRITE FOR YOUR COPY TODAY

Have you heard about *WINDIAL*?

This new, low cost, remote reading wind speed and direction indicating system is completely described on page 12 of the new catalogue.

FRIEZ INSTRUMENT DIVISION of
1460 Taylor Avenue, Baltimore 4, Maryland

Bendix
AVIATION CORPORATION